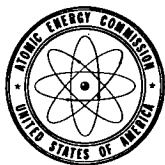


October 1969

Brief 69-10621



# AEC-NASA TECH BRIEF



AEC-NASA Tech Briefs describe innovations resulting from the research and development program of the U.S. AEC or from AEC-NASA interagency efforts. They are issued to encourage commercial application. Tech Briefs are published by NASA and may be purchased, at 15 cents each, from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

## Manganese-56 Coincidence-Counting Facility Precisely Measures Neutron-Source Strength

### The problem:

To develop an absolute counting facility for precise measurement of neutron-source strength. Customary counting methods, using the manganese-bath technique, lack the required precision. The  $\text{Mn}^{56}$ -decay scheme, a beta-counting technique, requires an extremely large liquid sample. Beta-scintillation counting, through direct contact of the solution with plastic scintillators, is complicated by light collection, surface area, etc.

### The solution:

A  $\text{Mn}^{56}$  counting facility capable of precise measurements (within 1%) of neutron-source strengths by the manganese-bath technique. Two-liter liquid samples of  $\text{Mn}^{56}\text{SO}_4$  are counted in a gamma-gamma coincidence arrangement by the two-stage absolute counting facility. The system is calibrated on an absolute scale by another unit that counts aliquots of strongly activated samples mixed with liquid scintillator in a  $4\pi\beta/\gamma$  (beta-gamma) coincidence mode. The combined system yields an absolute measurement. This facility combines nuclear instrumentation with coincidence-counting techniques to handle a wide range of radioisotope-counting requirements.

### How it's done:

A two-stage measurement provides the precision required in measurement of neutron-source strength. The gamma-gamma coincidence setup is designed for relatively low background, optimum efficiency, and long-term reproducibility; the beta-gamma coincidence unit has high counting-rate capabilities, maximum efficiency, and appropriate precision. Most of the electronic circuitry is common to both units.

In the  $\gamma\text{-}\gamma$  system, two 4- by 5-in. sodium iodide crystals are mounted so that 2 liters of  $\text{Mn}^{56}\text{SO}_4$  solution can surround the detectors in an annulus. The solution can be poured in through a tube that emerges from the lead shielding. Phototube signals are amplified and shaped in two doubly differentiating amplifiers. The pulses are timed from the zero crossing, selected as to energy by two single-channel pulse-height analyzers, and finally placed in coincidence. Manganese-56 gammas have energies of 0.845 MeV, in coincidence with 1.8 or 2.1 MeV. A delay, mixing, splitting, and repeating artifice permits counting of the 0.845-MeV radiation from either crystal, while still obtaining valid coincidences with the lines of higher energy from the opposite detector.

The  $\beta\text{-}\gamma$  system is based on the fact that  $\beta$ -emission of  $\text{Mn}^{56}$  is 100% in coincidence with  $\gamma$ -emission, and that most beta particles have high energies. Aliquots of activated Mn solution are added to a liquid scintillator, having a  $\beta$ -detection efficiency of 98% and a background level of 1.3 Hz, that can handle count rates up to  $10^4$  Hz with great accuracy. The accompanying gamma channel features a 3-in. NaI (TI) scintillator.

Operation of the beta detectors at room temperature with low noise rates is achieved by establishment of a photoelectron-coincidence requirement between two photomultiplier tubes with the same scintillation event. The pulses are fed directly from high-gain phototubes into a pair of tunnel-diode discriminators biased to accept pulses due to a single photoelectron; they are then fed into a coincidence analyzer and subsequently into time analysis with gamma channel.

(continued overleaf)

**Notes:**

1. Additional information available includes all details of procedures, method of intercalibration, data-accumulation and processing methods of sample preparation, and results of testing and evaluation of the two systems.
2. This information may interest the drug industry and the medical community.
3. Inquiries concerning this information may be directed to:

Office of Industrial Cooperation

Argonne National Laboratory

9700 South Cass Avenue

Argonne, Illinois 60439

Reference: B69-10621

Source: 1. A. DeVolpi and K.G.A. Porges

Reactor Physics Division

2. R. N. Larsen

Electronics Division

(ARG-90261)

**Patent status:**

Inquiries concerning rights for commercial use of this information may be made to:

Mr. George H. Lee, Chief

Chicago Patent Group

U.S. Atomic Energy Commission

Chicago Operations Office

9800 Cass Avenue

Argonne, Illinois 60439